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Reldan Insecticide Field-Tested on Western Spruce Budworm, Payette National Forest, Idaho, 1977

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Reldan (chlorpyrifos-methyl) was field-tested against western spruce budworm (*Choristoneura occidentalis* Freeman) on grand fir (*Abies grandis* [Dougl.] Lindl.) on the Payette National Forest, Idaho, in June and July 1977. The insecticide was applied by helicopter at dosages of 8, 4, and 2 oz a.i./gal/acre (0.56, 0.28, and 0.14 kg a.i./l/ha). Population reduction of 90.2, 88.3, and 63.4 percent mortality (check mortality 30 percent) at 15 days after treatment were obtained. At the dosage rates tested, Reldan killed fewer budworms but showed higher variability within treatments and less foliage protection than did Orthene and Sevin-4-oil, two other insecticides currently registered for use against western spruce budworm. Further testing of Reldan is not recommended.

Retrieval Terms: western spruce budworm, *Choristoneura occidentalis*, insecticides, Reldan, chlorpyrifos-methyl, aerial field tests

In Western North America, the western spruce budworm (*Choristoneura occidentalis* Freeman) is the most persistent and serious defoliator of the fir forests.[1] During an extensive outbreak, the accepted method of suppression is to aerially apply chemical insecticide against the feeding larvae. To find suitable insecticides for spruce budworm suppression, the Forest Service, U.S. Department of Agriculture, has underway an extensive program of laboratory screening and field testing of promising candidates. One of the chemicals evaluated in this program was Reldan (chlorpyrifos-methyl).[2] A relatively new insecticide with a broad range of activity against a variety of insects, Reldan was effective against the eastern spruce budworm, *Choristoneura fumiferana* (Clem) in Maine, giving 99 percent control of larvae at rates of 0.25 and 0.125 lb a.i./acre.[3]

This note reports field tests of Reldan on grand fir (*Abies grandis* [Dougl.] Lindl.) in the Payette National Forest, in June and July 1977. The objective of the tests was to evaluate Reldan at three dosage rates to determine its effectiveness at reducing a natural infestation of western spruce budworm. Highest dosages of Reldan used resulted in a level of control less than that achieved with lower dosages of Orthene (acephate) or Sevin-4-oil (carbaryl).

METHODS AND MATERIALS

The test site was in the Payette National Forest, about 100 miles (160 km) north of Boise, Idaho, and northwest of New Meadows (Adams County). All experimental plots were within a radius of 7 miles (11 km) of Brush Mountain and were located on the drainages of Boulder Creek, Round Valley Creek, and Mud Creek. Plots ranged from 4800- to 5600-ft (1462- to 1706-m) elevation.

Thirty potential plots, each 45 acres (18.2 ha), were located and preliminary samples taken to determine budworm populations. Later, 10 of the plots were discarded when it appeared that their populations would not exceed 20 larvae per 100 buds. The other 20 plots were selected for use and the three Reldan treatments or check randomly assigned to them.

Fifteen sample trees were selected per plot, all at least 200 ft (61 m) from the plot border and at least 100 ft (30.5 m) from each other. Grand fir was the predominant tree within the plots and contained higher populations of the budworm than did the other trees. Grand fir (*Abies grandis* [Dougl.] Lindl.), was selected as the sample tree, therefore, rather than Douglas-fir (*Pseudotsuga menziesii* var. *glauca* [Beissn.] Franco), which was also present. Sample trees were between 30 and 60 ft (9 and 18 m)

high with about one-half of the crown within 30 ft (9 m) of the ground. Larval populations were determined for each tree 24 h before spraying and at 5, 10, and 15 days after treatment.

Larvae and buds were counted on 15-inch (38-cm) branches removed from midcrown of the sample trees.[4] Two branches were removed prespray and four postspray.

Samples were evaluated in a field laboratory where larvae were removed by beating the branches inside a plastic barrel.[5] Number of buds and total number of budworm larvae or pupae sampled per tree were recorded. Population density was expressed as the number of larvae per 100 buds.

Defoliation was estimated from the foliage collected at the last sampling interval by visually examining each new shoot and assessing the amount of foliage destroyed by larval feeding.[6] Each bud was categorized into one of four defoliation classes (25, 50, 75, and 100 percent), and the categories averaged to give the percent defoliation for the four branches sampled from each tree.

A Bell 47 GB3 helicopter equipped with a Simplex spray system containing two 60 gal (227 *l*) tanks, a hydraulic driven pump, and a 30-ft (9.14-m) boom applied the spray.[7] The equipment was calibrated to show that 8002 nozzles at 40 psi (2.8 kg/cm^2) had a flow rate of 0.24 gal (0.9. *l*)/min/nozzle and provided 4.5 acre/min (1.85 ha/min) application. For maximum spray breakup 19 nozzles mounted forward and down were used.

All plots were marked by placing fluorescent panels in trees at the four corners to serve as markers for the spray pilot. Tree marking was done with a line-throwing gun to place a 20-lb (9.1-kg) monofilament fishline over the top 6 ft (1.8 m) of a corner tree. The line was used to hoist the 18-inch (45.7-cm) by 6-ft (1.8-m) panel into the treetop and retrieve it afterwards.

Reldan was applied at rates of 8, 4, and 2 oz a.i. per acre (0.56, 0.28, 0.14 kg a.i./ha) in 1 gal diesel fuel with 3.8 g of Rhodamine Extra Base dye in 90-cm^3 oleic acid (used as a carrier for the dye) as a marking agent. Reldan was manufactured by the Dow Chemical Company and is also known as Dowco 214 and chlorpyrifos-methyl. The formulation used was M-3486, which contained 6 lb a.i./gal. Reldan was applied under EPA Experimental Use Permit 464-EUP-48. The helicopter applied the spray in passes 50 ft (15 m) above mean treetops, at 45 mph (72.6 km/h). A ground observer directed the helicopter to the plot and remained in contact with him during treatment to check swath spacing, watch for plugged nozzles, and leakage of spray.

During spraying, air temperature, humidity, and windspeed were recorded at ground level at 15-min intervals starting ½ h before treatment of each plot and continuing until ½ h after treatment. Smoke bombs ignited at the beginning of the treatment were used to determine direction and to approximate speed of winds at ground level.

White Kromekote cards, 4 by 5 inches (10.2 by 12.7 cm) were used to assess spray deposit at ground level. One card was placed in an opening immediately adjacent to each sample tree the morning of spraying. After spraying, the cards were left out for about 1 h before they were collected to assure complete drying of the spray. The Department of Advanced Instrumentation, University of California, Davis, used an Imanco 720 Quantimet Image Analyzer to read the cards. The data were analyzed to deter-

Table 1—*Budworm larvae population density and development at time of Reldan treatment, Payette National Forest, Idaho, 1977*

Treatment and replicate	Larvae per 100 buds[1]	Larvae, by instar[2]				
		2	3	4	5	6
Reldan 8 oz/acre (0.56 kg/ha):						
A	59.9	0	7	29	64	0
B	22.1	0	0	31	68	1
C	50.0	0	0	22	78	0
D	29.6	0	10	35	54	1
E	35.5	0	6	30	59	5
Mean	39.4	0	5	29	65	1
Reldan 4 oz/acre (0.28 kg/ha):						
A	45.8	0	11	39	50	0
B	47.9	0	3	50	47	0
C	35.5	0	7	51	42	0
D	28.6	0	0	26	68	6
E	28.2	0	9	16	63	12
Mean	36.8	0	6	36	54	4
Reldan 2 oz/acre (0.14 kg/ha):						
A	38.8	0	12	36	52	0
B	34.4	0	0	22	72	6
C	39.3	0	0	14	86	0
D	40.3	0	6	34	60	0
E	46.1	0	7	68	25	0
Mean	39.8	0	5	35	59	1
Check:						
A	31.5	0	9	16	75	0
B	35.1	(3)	(3)	(3)	(3)	(3)
C	35.9	0	0	23	77	0
D	37.5	0	17	78	5	0
E	34.8	(3)	(3)	(3)	(3)	(3)
Mean	33.0	0	9	39	52	0

[1]Density at prespray, 24 h before treatment.

[2]Counts made from 50 to 100 insects collected from five predesignated trees, not sample trees, 2 to 4 days before treatment.

[3]Data missing.

mine volume mean diameter (VMD)—the theoretical center of the spray droplet size spectrum; that is, half of the spray mass is in droplets larger than the VMD and half is in droplets smaller than the VMD of the drops, and the number of drops per square centimeter.

Analysis of variance was used to determine if significant differences existed between treatment means; if so, Tukey's test was used to show where significant differences occurred between pairs of treatments.

TREATMENT

Treatments were applied when the new foliage was completely open, exposing the budworm, but before appreciable numbers had reached 6th instar (*table 1*). More than 50 percent of the larvae were in the 5th instar, but less than 5 percent were in the 6th. No pupation had occurred at time of spraying.

Treatments began on June 22 and were completed on June 24. Time and date of spraying of each plot and weather conditions existing in the plot at ground level at time of spraying were recorded (*table 2*). Weather at the time of spraying was nearly ideal. The only winds were normal down-slope and down-valley winds. The only rain fell 10 days after treatment on July 3, 0.2 inch (0.5 cm), and on July 4, 0.52 inch (1.32 cm).

Reldan was mixed immediately before spraying in a 120-gal (454-*l*) mixing tank at the heliport. As the first dosage was being applied, the second dosage was mixed. Reldan mixed readily with the diesel fuel and did not clog nozzles or screens, or dissolve gaskets. The helicopter took less than 15 min to treat each 45-acre (18.2-ha) plot.

RESULTS

Spray coverage was assessed from the Kromekote cards (*table 3*). All of the cards contained some spray spots; no apparent skips were detected in the coverage of the plots.

Samples of spray were collected from the mixing tank at time of loading and analyzed for the actual amount of Reldan

Table 2—*Weather conditions at start of aerial spraying, Reldan field test, Payette National Forest, Idaho, 1977*

Treatment and replicate	Date treated	Time at start of spraying	Temp.	Relative humidity	Wind	
			°F (°C)	*Percent*	*mph*	*(km/h)*
Reldan 8 oz/acre (0.56 kg/ha):						
A	6/23	0730	52 (11.1)	89	3	(4.8)
B	6/22	0740	55 (12.8)	73	0	0
C	6/23	0703	57 (13.9)	60	2	(3.2)
D	6/24	0550	54 (12.2)	62	0	0
E	6/24	0630	56 (13.3)	65	4	(6.4)
Reldan 4 oz/acre (0.28 kg/ha):						
A	6/24	0755	48 (8.9)	88	<2	(3.2)
B	6/22	0713	45 (7.2)	84	<2	(3.2
C	6/24	0815	51 (10.6)	88	0	0
D	6/23	0600	47 (8.3)	94	0	0
E	6/23	0631	49 (9.4)	83	2	(3.2)
Reldan 2 oz/acre (0.14 kg/ha):						
A	6/23	0830	50 (50.0)	82	<2	(3.2)
B	6/23	0800	52 (11.8)	89	<2	(3.2)
C	6/24	0730	59 (15.0)	63	<2	(3.2)
D	6/22	0631	54 (12.2)	60	0	0
E	6/24	0700	51 (10.6)	77	2	(3.2)

Table 3—*Spray deposit and tank samples, Reldan field test, Payette National Forest, McCall, Idaho, 1977*

Treatment and replicate	Spray deposit		Tank sample
	Drops/cm²	*VMD[1]*	*Pct expected*
Reldan 8 oz/acre (0.56 kg/ha):			
A	10.5	94.4	92
B	19.5	107.9	104
C	8.8	93.0	104
D	5.9	84.7	127
E	5.2	105.2	127
Mean	10.0	96.6	110
Reldan 4 oz/acre (0.28 kg/ha):			
A	14.8	93.6	94
B	5.7	92.3	89
C	5.6	92.4	89
D	17.7	86.3	103
E	5.7	92.3	103
Mean	9.9	91.4	96
Reldan 2 oz/acre (0.14 kg/ha):			
A	18.8	83.3	Lost
B	15.4	99.6	107
C	10.0	90.8	109
D	19.0	83.4	116
E	2.9	99.6	116
Mean	13.2	91.3	112

[1] Theoretical center of the spray droplet size spectrum; half of spray mass is in droplets larger than volume mean diameter, and half is smaller.

in the final mix. More variation was found in the concentration of the final mix than was expected. One reason for this discrepancy was later identified when a sample of the Reldan formulation provided by the manufacturer was analyzed and found to contain 6.43 lbs a.i./gal (2.92 kg a.i./3.78 *l*) instead of the expected 6 lb a.i./gal (2.73 kg a.i./3.78 *l*).

Effectiveness of Reldan against the western spruce budworm larvae was expressed as population reduction and as percent mortality (*table 4*). At 15 days, the end of the sampling period, populations were reduced significantly more ($P = 0.05$) in all treated plots than in the check plots. Plots treated at the 4-oz (0.28-kg) and 8-oz (0.56-kg) rates did not differ significantly at the level of sensitivity possible with this test design, but both differed significantly from the plots treated at the 2-oz (0.14-kg) rate. Most of the insects apparently died within the first 5 days after treatment, with some additional mortality occurring between 5 and 10 days.

Data on defoliation of the sample trees within the treatment plots showed no significant differences among the four treatment levels (*table 4*).

DISCUSSION

Reldan mixed readily with the diesel fuel carrier and showed no settling or precipitation in the tanks, pumps or booms, and no crystals, undissolved particles, or contaminant on the 50-mesh nozzle screens. No mechanical problems

Table 4—*Population reduction of western spruce budworm larvae (uncorrected for natural mortality) and defoliation, after treatment by Reldan, Payette National Forest, Idaho, 1977*

Treatment and replicate	Mean larvae/100 buds				Mean population reduction			Defoliation
	Prespray	Postspray						
	24 h	5 days	10 days	15 days	5 days	10 days	15 days	15 days
					Percent			
Reldan 8 oz/acre (0.54 kg/ha):								
A	59.9	29.5	9.7	10.4	50.7	83.8	82.7	80.0
B	22.1	5.6	1.2	1.4	74.8	94.4	93.5	88.5
C	50.0	4.0	3.3	3.7	91.9	93.4	92.6	46.8
D	29.6	3.0	2.2	3.1	89.9	92.4	89.5	71.7
E	35.4	5.2	4.7	2.6	85.3	86.6	92.7	69.1
Mean	39.4a[1]	9.5a	4.2a	4.2a	78.5a	90.1a	90.2a	71.2a
Reldan 4 oz/acre (0.28 kg/ha):								
A	45.8	10.1	3.4	5.1	78.0	92.5	88.9	57.1
B	47.9	8.1	4.3	4.0	83.1	91.1	91.6	75.8
C	35.5	16.2	7.4	8.5	54.5	79.1	76.0	76.6
D	26.6	2.0	2.1	1.3	92.5	92.1	95.1	71.1
E	28.2	3.6	4.1	2.9	87.4	85.5	89.9	88.1
Mean	36.8a	8.0a	4.2ab	4.3ab	79.1a	88.1a	88.3a	73.9a
Reldan 2 oz/acre (0.14 kg/ha):								
A	38.8	26.1	25.7	18.9	32.7	33.8	51.2	77.8
B	34.4	16.8	12.0	24.3	51.3	65.2	29.4	68.6
C	39.3	24.1	16.7	8.7	38.8	57.5	77.8	89.2
D	40.3	11.9	5.6	4.2	70.5	86.2	89.6	68.4
E	46.1	11.5	15.4	14.2	75.1	66.6	69.1	82.1
Mean	39.8a	18.1b	15.1b	14.1b	53.7b	61.9b	63.4b	77.2a
Check:								
A	21.5	26.6	21.7	25.9	0.0	0.0	0.0	97.1
B	35.1	29.1	23.5	25.0	17.0	33.0	28.8	77.9
C	35.9	33.8	28.0	26.7	5.8	21.9	25.6	74.5
D	37.5	19.1	16.3	15.8	49.0	56.6	57.9	76.9
E	34.8	19.5	13.6	11.8	44.1	60.9	66.1	81.0
Mean	33.0a	25.6b	20.6b	21.1c	23.2c	34.5c	35.7c	81.5a

[1] Means in same columns followed by same letter do not differ significantly at the 5 percent level.

delayed or interrupted treatment. Individual plots observed during spraying indicated that the correct number of swaths were applied and that swath spacing appeared to be uniform. On randomly selected plots, swaths were chosen where the aircraft could be observed against two corner flags and timed. These observations confirmed that the pilot was flying within 2 to 5 mph of the correct speed.

Weather conditions at time of treatment are critical to the deposit of spray in the target area; that is, on the budworm larvae or on the foliage on which they are feeding. Weather conditions in all plots during spraying were within ranges desirable for successful spraying (*table 2*). We believe that the weather during this test was, in fact, as close to optimum as could be expected in coniferous forests of the Rocky Mountains.

Good coverage was confirmed by analysis of spray cards left in the plots during treatment. Such cards are of relatively limited use because the number and size range of the droplets that reach them can be influenced greatly by such factors as canopy density, location of the cards, weather conditions at the time of spray, and others. The cards provide a limited tool, however, by which deposit between plots in the same test can be compared. In this test, the cards confirmed that all plots were treated, and that there were no detectable skips in the coverage within individual plots since all cards showed a minimum coverage. Cards can also be used to indicate if poor spray coverage was the cause of poor mortality. If this is the situation, a general relationship can often be seen with

Table 5—*Reductions in western spruce budworm populations by Reldan, Orthene, and Sevin-4-oil insecticides, by test dosages, dates, and locations*

Test date, location	Plot size	Tree type[1]	Dosage tested	Replicate/ dosage	Trees sampled/ plot	Prespray population	Sampling period postspray	Uncorrected population reduction	Range population reduction	$\bar{X}$ defoliation	Reference[2]
	Acres		*lb/acre*			*Larvae/ 100 buds*	*Days*		*Percent*		
						Reldan					
1977, Southwest Idaho	50	GF	0.5	5	15	39.4	15	90.2 ± 2.0	82.7 - 93.5	71.2	
			0.25	5	15	36.8	15	88.3 ± 3.2	78.9 - 95.1	73.9	
			0.125	5	15	39.8	15	63.4 ± 10.6	29.5 - 89.6	77.2	
			Check	5	15	33.0	15	35.7 ± 11.9	0.0 - 66.0	81.5	
						Orthene					
1976, Southeast Idaho	100	DF	1.0	3	25	13.0	15	98.8 ± .6	98.0 - 99.9	49.0	Markin 1979[10]
			.5	3	25	17.8	15	93.0 ± 2.9	89.3 - 98.3	76.5	
			0.125	3	25	11.8	15	77.5 ± 6.9	64.2 - 87.2	76.6	
			Check	3	25	15.7	15	48.3 ± 11.2	30.8 - 69.4	86.0	
1977, Southwest Idaho	100	DF, GF	0.5	4	75	32.4	10	91.0 ± 2.2	84.2 - 93.8	57.1	Stipe and others 1979[11]
			Check	4	75	27.3		35.2 ± 4.5	26.6 - 46.7	59.0	
1976, Montana	2000-3000	DF	0.5	3	75	17.5	10	93.8 ± 1.7	90.7 - 96.7	31.6	Flavell and others 1976[12]
			Check	3	75	11.7		33.2 ± 13.5	15.5 - 54.7	43.4	
						Sevin-4-oil					
1979, Central Montana	50	DF	1.0	5	15	8.2	15	92.8 ± 1.21	88.6 - 94.1	29.8	Markin and others 1980[13]
			.5	5	15	8.6		93.5 ± 3.3	80.5 - 99.0	27.5	
			.25	5	15	9.8		81.3 ± .6	81.7 - 84.3	33.2	
			Check	5	15	10.4		45.0 ± 6.9	18.5 - 56.8		
1977, New Mexico	[3]6000	DF,WF	1.0	6	75	14.9	14	93.1 ± .6	90.7 - 94.2	26.5	Parker and others 1978[14]
			Check	6	75	12.4		44.5 ± 5.0	33.8 - 69.7	40.7	
1976, Washington	7663		1.0	11	—	—	14	96.2 ± —	— —	—	Mounts and others 1978[15]
			No check								
1977, Washington	[4]	DF, TF	1.0	12	78	18.0	14	91.7 ± 1.7	88.2 - 94.1		Mounts and others 1978[15]
			Check	3	78	20.6		59.0 ± 8.1	49.5 - 75.6		

[1]DF = Douglas-fir; GF = grand fir; TF = true firs; WF = white fir.

[2]See notes section for complete citations.

[3]Average plot size.

[4]Acreage sprayed totaled 356,661.

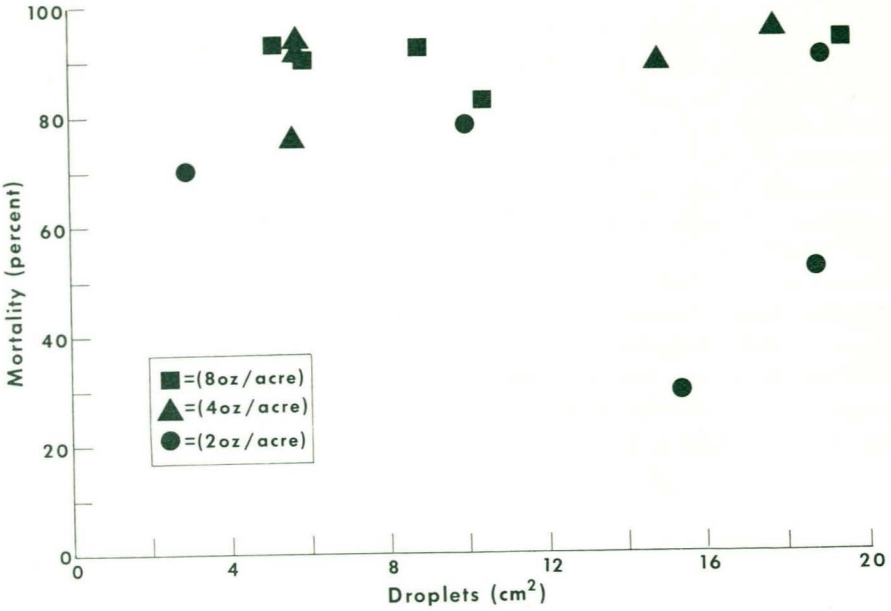

Figure 1—At 15 days postspray, populations of budworm were reduced significantly more (P = 0.05) in all treated plots than in the check plots. Plots treated at the 4-oz (0.28-kg) and 8-oz (0.56-kg) rates did not differ significantly from plots treated at the 2-oz (0.14-kg) rate. Symbols represent the different dosages used: ■ = 8 oz/acre, ▲ = 4 oz/acre, and ● = 2 oz/acre. Each point represents the mean of 15 sample trees for each plot.

the plots having the poorest coverage (expressed as drop/cm^2) also having the lowest mortality.[89] In *figure 1* the mean deposit (drops per cm^2, see *table 3*) for all 15 treated plots are plotted against the percent population reduction for the same plots at 15 days postspray (*table 4*). No relationship is apparent for any of the three dosage rates; therefore, a tentative conclusion is that the observed variations in larval mortality are most likely the result of a property of the insecticide, that is, its dosage rather than its deposit.

The results suggest that the desired concentrations of Reldan (actually a little higher than aimed for) were applied by the aircraft over the designated plots, and that weather conditions were suitable for the spray to land in the plots. In general, it appears that the plots received an adequate treatment as compared to what could be expected in a coniferous forest within the Rocky Mountains. We concluded that the resulting mortality primarily represents the action of the pesticide combined with the natural mortality (*table 4*).

Although all dosage levels tested resulted in significant kill as compared with the control, the highest dosages of Reldan gave a level of control below that normally obtained with the two insecticides presently registered and most commonly used for control of the western spruce budworm (*table 5*). A statistical comparison between the results of the Reldan tests and those earlier tests of Orthene (acephate) and Sevin-4-oil (carbaryl) is impossible because of variation in test design, number of replicates, trees per replicate, time of sampling, and other. A tentative conclusion can be drawn, however, in that under ideal application conditions, the average resulting mortality for Reldan appears to be 4 and 9 percent below that which might be expected if either of the two presently used insecticides had been applied.

Another possible difference between Reldan and Sevin-4-oil and Orthene is the apparent higher variability in population reduction between individual plots when treated with the same dosage of Reldan. The range of population reduction for the Reldan plots generally seems higher than has been encountered with the other two materials (*table 5*). The reason for this higher variability is unknown, but it makes us uneasy to extrapolate to what might happen under large-scale operation programs with Reldan. In such programs, the high variability could be compounded by the inherent variability encountered in any large-scale program; that is, variability in treatment, meteorological conditions, spray coverages, stages of insect development, and other.

A final difference noted between the results of this Reldan test and previous tests with Orthene and Sevin, was the poor degree of foliage protection obtained. In previous tests of Orthene and Sevin against 4th and 5th instar larvae, it has usually been possible to show that significant amounts of foliage were protected in treated plots when compared with check plots. This was not true with Reldan. Only small differences were found (*table 4*) and these differences were not great enough to be significantly different.

CONCLUSIONS

The dosages of Reldan we tested yielded low insect mortality, high unexpected variability within treatments, and poor foliage protections. The degree of control achieved was below that which could normally be expected from two insecticides now registered for control of western spruce budworm: Orthene and Sevin. Perhaps we might have obtained better results had higher dosages of Reldan been tested. But higher dosages might not be commercially or environmentally acceptable. We recommend that no further field testing of Reldan be done because higher insect mortality can be achieved with currently registered insecticides.

Acknowledgments:

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NOTES

[1]Carolin, V. M.; Honing, F. W. *Western spruce budworm*. Forest Pest Leafl. 53. Washington, DC: U.S. Department of Agriculture; 1972. 8 p.

[2]This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State or Federal agencies or both before they can be recommended.

[3]Dimond, J. B. *Efficacy of materials tested for control of spruce budworm damage in Maine, 1975. I. Chemical insecticides, II. Biological insecticides*. Misc. Rep. 174. Orono, MA: Maine Life Science and Agric. Exp. Stn.; 1975. 16 p.

[4]Carolin, V. M.; Coulter, W. K. *Sampling population of western spruce budworm and predicting defoliation on Douglas-fir in eastern Oregon*. Res. Paper PNW-149. Portland, OR: Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1972. 38 p.

[5]Martineau, R.; Benoit, P. *A sampling technique for estimating numerical trends in larvae populations of insect defoliators on conifers. II. Modification and operational use of the technique for extensive sampling of spruce budworm population in Quebec*. Phytoprotection 54: 23-31; 1973.

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[7]Trade names and commercial enterprises or products are mentioned solely for information. No endorsement by the U.S. Department of Agriculture is implied.

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